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TITLE: STACKED PIEZOELECTRIC ELEMENT

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ABSTRACT:

PURPOSE: To simplify the process of connection with every other inner electrode, in a stacked piezoelectric element used as an actuator and also, prevent the inferiority of connection such as short circuit, etc., even if it is a film piezoelectric element where a piezoelectric film is made very thin.

CONSTITUTION: A conductive film 13, which contains conductive particles 31 and besides changes the concentration of contained conductive particles in the direction of thickness, is formed at the side of a piezoelectric element where piezoelectric material films 11 and inner electrodes 12 are stacked alternately. And, a copper foil (outer electrode) 15 and alternate inner electrodes 12 are electrically connected with each other by pressing the

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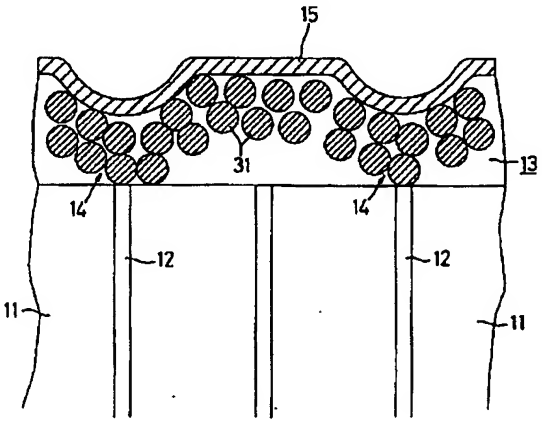
(54)【発明の名称】　積層型圧電素子

(57)【要約】
【目的】　アクチュエータとして用いる積層型圧電素子において、内部電極の一層おきの接続工程を簡略化するとともに、圧電膜が非常に薄く形成された薄膜の圧電素子であっても、短絡等の接続不良を防止する。
【構成】　圧電材料膜１１と内部電極１２とが交互に積層された圧電素子の側面に、導電性粒子３１を含有しかつその含有濃度を膜厚方向に変化せしめた導電膜１３を形成し、その導電膜１３の一層おきの内部電極１２と対応する部分を、導電性粒子３１が含有濃度の低い部分を突き破って内部電極１２と接触するように加圧し、その加圧した部分のみを選択的に導電部１４とすることにより、銅箔（外部電極）１５と一層おきの内部電極１２とを電気的に接続する。



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【特許請求の範囲】

【請求項1】　圧電材料と内部電極とが交互に積層されている積層型圧電素子であって、

その積層型圧電素子の側面上に連続して形成されるとともに、導電性粒子を含有し、かつその含有濃度を膜厚方向に変化せしめた構造をなし、部分的に圧縮することにより選択的に導電性を持たせることができる導電膜と、その導電膜上に連続して形成されるとともに、前記内部電極と導電膜を介して電気的に接続された外部電極とを備えたことを特徴とする積層型圧電素子。

【請求項2】　前記導電膜は、導電性粒子を含有する樹脂接着剤からなる1層構造であることを特徴とする請求項1記載の積層型圧電素子。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、圧電材料の薄膜を多数枚積層し、電圧を印加することにより縦方向の変位を得る積層型圧電素子に関するものである。

【0002】

【従来の技術】積層型圧電素子を製造する場合、内部電極を一層おきに接続する必要があるが、従来の積層コンデンサ方式を用いると、内部電極の面積が素子の断面積より小さいため電界が全面に発生せず、変位を阻害するばかりでなく不均一な部分に応力集中が発生し、ついには破壊するという致命的な欠点がある。また、積層時の位置決めが難しく、多くても数十枚程度の積層枚数が限界であり、同じ印加電圧の場合、素子の変位量は積層枚数に比例するため、大きな変位量を発生する素子を製造するのは困難であった。

【0003】この欠点を解消するために、圧電シートの全面に電極を印刷して積層する方法、すなわち、内部電極の面積と素子の断面積を等しくする構造が一般的になっているが、このような構造の場合、内部電極を一層おきに接続するためには、特公昭63－17354号公報に開示されるような方法（図6）や、特開昭62－211974号公報に開示されるような方法（図7）を用いて絶縁処理しなければならない。すなわち、図6に示す積層型圧電素子では、一層おきにガラス等の絶縁物（絶縁層）41をスクリーン印刷や電気泳動法により付着させた後、焼き付けて固着し、その上から外部電極となる銀ペースト42を塗布して、内部電極43を一層おきに接続している。また、図7（a），（b）に示す積層型圧電素子では、同じくガラス等の絶縁層51を形成し、一層おきに内部電極53と絶縁層51上に形成された外部電極52とが電気的に接続されている。

【0004】しかしながら、図6および図7に示す構造の圧電素子では素子の側面上に絶縁層を形成する工程と、その上から内部電極を接続するための外部電極を形成する工程とが必要になるが、いずれの場合にも絶縁層を先に形成し、その後に外部電極を形成することになるため、それらの工程を同時に行うことはできず、しかも、素子本体に対して直接形成しなければならないため工程数が多く、歩留まりが低くなるという欠点がある。また、図6に示す構造の圧電素子の場合、側面に露出する内部電極43の端部に一層おきに絶縁層41が形成されているが、その方法としてスクリーン印刷を用いた場合は、印刷が非常に微細なためカスレ、滲み等で本来接続される部分が導通不良になったり、絶縁される部分が短絡したりすることがあった。電気泳動法の場合も、素子の駆動電圧に耐えられるだけの厚さの絶縁層41を均一に形成することは難しく、同じく絶縁破壊による短絡等の問題があった。

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【0005】一方、図7に示す構造の圧電素子では、絶縁層51を比較的容易に形成できるが、絶縁層51上の外部電極52と内部電極53との接続法が難しく、スクリーン印刷の場合では素子面と絶縁層の段差があるため、その段差部分では導電材ペーストの印刷が難しく、導通不良や短絡不良が問題になっていた。さらに、いずれの方法を用いても、絶縁層や外部電極ペーストを高温で焼成する工程が入るため製造コストが上昇するとともに、圧電材料膜の厚さが100μm以下になると接続が非常に困難になるという問題点があった。

【0006】そこで、発明者らはこれらの問題を解決するため、図8に示すような分散粒子タイプの異方性導電膜を用いて素子の製作を試みた。この異方性導電膜は、100μm程度の厚さを持つ絶縁物の接着シート61中に、粒径数十μmの導電性粒子62が互いに接触しないように分散された状態で含有されており、膜の厚み方向に部分的に加圧することにより粒子同士が接触して、厚み方向のみ導電性を持たせることができる。

【0007】これによって、絶縁層を形成する工程が省略され、高温での焼成工程もないため大幅に工程を削減でき、素子の製造コストを押さえることができる。また、外部電極の形成工程において、導電材または絶縁材のペーストを用いていないため、滲みやカスレによる接続不良が皆無となった。

【0008】

【発明が解決しようとする課題】ところが、図8に示すような分散粒子タイプの異方性導電膜を用いた場合、導電性粒子62間の距離が狭いと、粒子同士の接触により膜の厚み方向に対して垂直方向にも導電性が得られてしまうため、内部電極を含めた圧電膜の一層分の厚さが、たとえば100μm以下になると、一層おきの接続が困難になるという問題点が残った。

【0009】本発明は、このような問題点を解決するためになされたものであり、絶縁層の形成という概念を排除して工程を簡略化し得ることはもとより、圧電膜が非常に薄く形成された薄膜の圧電素子であっても、外部電極と内部電極とを確実に接続して、導通不良や絶縁不良を防止できることを目的としている。

【００１０】
【課題を解決するための手段】この目的を達成するために本発明の積層型圧電素子は、その側面上に連続して形成されるとともに、導電性粒子を含有し、かつその含有濃度を膜厚方向に変化せしめた構造をなし、部分的に圧縮することにより選択的に導電性を持たせることができる導電膜と、その導電膜上に連続して形成されるとともに、内部電極と導電膜を介して電気的に接続された外部電極とを備えている。また、導電膜は、導電性粒子を含有する樹脂接着剤からなる１層構造とされている。
【００１１】
【作用】上記の構成を有する本発明の積層型圧電素子は、導電膜を圧縮することにより、局部的に加圧された含有濃度の高い部分の導電性粒子が、含有濃度の低い部分を突き破って、内部電極と接触するようになり、所望の部分にのみ選択的に導電性を持たせることができる。そして、加圧されない部分は、粒子の含有濃度の低い部分によって絶縁が確保されるため、導電性粒子が一定の距離だけ離れるように分散されていなければならないといった制限はなく、含有濃度の高い部分全体に粒子を含有させることができるので、圧電材料膜が非常に薄く形成された薄膜の圧電素子であっても、外部電極と内部電極とを確実に接続して、導通不良や絶縁不良が起きるのを確実に防止できる。
【００１２】また、導電膜を樹脂接着剤からなる１層構造によつて構成しているため、高温で焼き付けたりするなどの工程が必要でなく、素子の製造コストを抑えることができる。
【００１３】
【実施例】以下、本発明を具体化した一実施例を図面を参照して説明する。
【００１４】図1は、本発明による積層型圧電素子の断面図であり、圧電材料膜１１と内部電極１２とが交互に重なる積層体の側面において、素子の積層方向に全ての圧電材料膜１１にかかるように導電膜１３が形成され、一層おきに導電部１４を持っている。さらに、その導電膜１３上には外部電極として銅箔１５が形成され、導電部１４を介して内部電極１２と電気的に接続されている。導電膜１３は、導電性粒子を含有し、かつその含有濃度を膜厚方向に連続的に変化せしめた１層構造になっている。
【００１５】次に、図１に示される積層型圧電素子の製造方法を図２～図５を参照して説明する。
【００１６】先ず、ＰＺＴを主成分とする圧電材料を所望の組成に混合した後、８５０℃で仮焼成した粉末に５重量部のバインダーと微量の可塑材および消泡剤を添加し、有機溶媒中に分散させスラリー状にする。このスラリーをドクターブレード法により所定の厚さに成形しグリーンシートとする。このグリーンシート上に内部電極１２としてＰｄペーストをスクリーン印刷し、所定寸法に打ち抜いたものを所定枚数積層し、熱プレスにより一体化する。脱脂後、約１２００℃で焼結を行い、図2に示すようなブロック状の焼結積層体５としてから、素子単体６の１個分の大きさまでスライスする。
【００１７】素子本体とは別に、図3に示すように銅箔１５上に平均粒径２０～３０μmの銅粉末（導電性粒子）３１を含有させた樹脂接着剤、たとえば、熱硬化性のエポキシ系接着剤を７０μm程度の厚さに均一に塗布し、硬化温度よりも低い温度で加熱して軟化状態にし、銅粉末（導電性粒子）３１を比重差により沈降させ、さらに半硬化の状態にする。これによって、銅粉末（導電性粒子）３１の含有濃度を膜厚方向に連続的に変化せしめた１層構造の導電膜１３、すなわち、銅箔１５に近いがわほど銅粉末（導電性粒子）３１の含有濃度が高く、銅箔１５から離れるほど含有濃度が低くなり、ついには銅粉末（導電性粒子）３１をほとんど含有しない、あるいは全く含有しない１層構造の導電膜１３を形成する。
【００１８】次に、この導電膜１３を素子の幅より狭い幅で切断し、スライスした状態の素子の一つの側面に全ての圧電材料膜１１にかかるような長さで仮止めする。そして、図４に示すように、内部電極１２の２間隔分のピッチＰで、先端が０．０５mm程度のＲ（半径０．０５mmの円弧）に形成された突起状の山部１６ａを複数個持った加圧用治具１６を用意し、その各突起状の山部１６ａと一層おきの内部電極１２の位置がかみ合うように位置決めを行い、荷重をかけながら全体を１５０℃で３０分間加熱すると、導電膜１３および銅箔１５が素子本体に接着されると同時に、加圧した部分の導電膜１３において、含有濃度の高い部分の銅粉末（導電性粒子）３１が、図５に示すように、粒子の含有濃度の低い部分を突き破って内部電極１２と接触し、かつ外部電極である銅箔１５とも接触して、導電部１４となり、一層おきに内部電極１２と銅箔１５とが電気的に接続された形となる。
【００１９】別の側面においても、同様に一層分ずらして内部電極１２と銅箔１５を導電膜１３を介して接続する。この後、銅箔１５の一部に電力供給用のリード線を取り付け、外装および分極を施して完成品となる。
【００２０】ときに、本実施例における導電膜１３は、銅粉末（導電性粒子）３１の含有濃度を膜厚方向に連続的に変化せしめた１層構造としているため、たとえば、銅箔１５上に平均粒径２０～３０μmの銅粉末（導電性粒子）３１を含有させた樹脂接着剤、たとえば、熱硬化性のエポキシ系接着剤を５０μm程度の厚さに均一に塗布し、硬化温度よりも低い温度で加熱して半硬化の状態にし、さらに、その上に接着剤のみを同様に均一に塗布、加熱して半硬化させ、これによって、銅粉末（導電性粒子）３１を含有したエポキシ系接着剤からなる層と、エポキシ系接着剤のみからなる層との、２層構造からなる導電膜１３を用いた場合に比べ、次のような効果

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がある。

【００２１】第１に、樹脂接着剤を塗布するために２度スクリーン印刷をしなくてもよく、工数低減となる。また、２度の加熱工程を必要としない。第２に、２層構造の場合は、２度スクリーン印刷をすることにより、導電膜に厚みムラが生じ易いが、１層構造の場合は、膜厚の調整が２層構造より楽である。

【００２２】なお、本発明は上述した実施例に限定されるものではなく、その主旨を逸脱しない限り種々の変更を加えることができる。たとえば、導電性粒子３１として、銅粉末を用いる代わりに、ニッケルや銀などの金属粉末を用いてもよい。また、銅箔１５の一方をそのまま延長すればリード線の代わりになる。さらに、前記加圧用治具１６を２つ用意してその各山部と谷部とがかみ合うような位置で素子を挟めば、２面同時に加圧することができる。

【００２３】

【発明の効果】以上説明したことから明かなように本発明の積層型圧電素子は、絶縁層を個々の素子に形成する必要がなく、高温での焼成工程もないため大幅に工程を削減でき、素子の製造コストを押さえることができ、また、外部電極の形成工程において、導電材または絶縁材のペーストを用いていないため、滲みやカスレによる接続不良を皆無とし得ることはもとより、圧電材料膜が非常に薄く形成された薄膜の圧電素子であっても、外部電極と内部電極とを確実に接続して、導通不良や絶縁不良を起こすおそれはない。

【００２４】また、導電膜を導電性粒子を含有する樹脂接着剤からなる１層構造としているため、たとえば、導

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電性粒子を比重差により沈降させる等の方法で容易に製造することができ、しかも、高温で焼き付けたりするなどの工程が必要でなく、素子の製造コストを押さえることができる。

【図面の簡単な説明】

【図１】図１は本発明の一実施例を示す積層型圧電素子の断面図である。

【図２】図２はブロック状の焼結積層体から素子１個分の大きさまで切り出す説明図である。

【図３】図３は銅箔と１層構造の導電膜とを示す断面図である。

【図４】図４は導電膜を加圧する工程の説明図である。

【図５】図５は加圧により導電部が形成された状態を示す説明図である。

【図６】図６は従来の積層型圧電素子の断面図である。

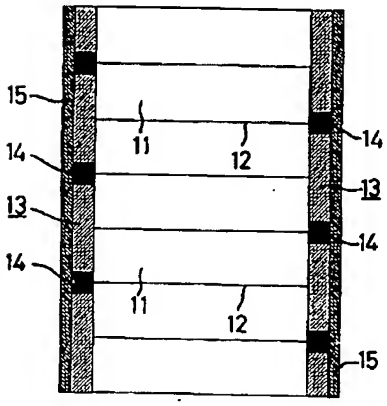
【図７】図７は従来の他の積層型圧電素子を示すもので、（ａ）は側面図、（ｂ）は（ａ）のＢ－Ｂ線断面図である。

【図８】図８は先に提案された異方性導電膜の断面図である。

【符号の説明】

１１　圧電材料膜
１２　内部電極
１３　導電膜
１４　導電部
１５　銅箔（外部電極）
１６　加圧用治具
３１　銅粉末（導電性粒子）

【図１】



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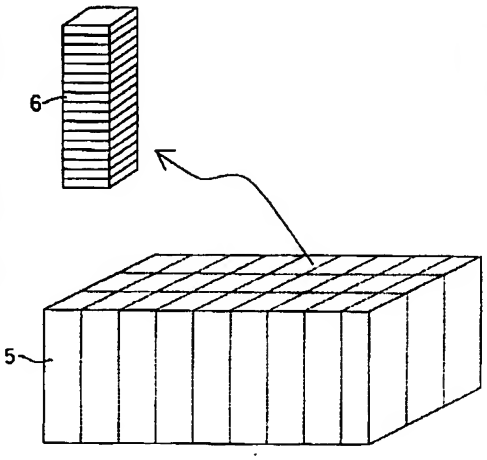

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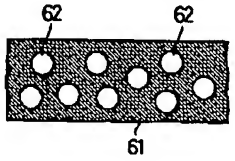

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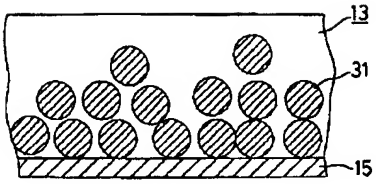
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31
15

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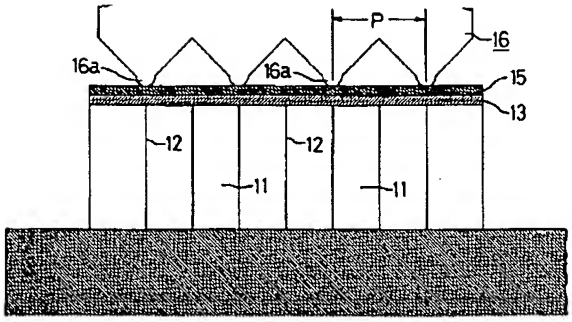
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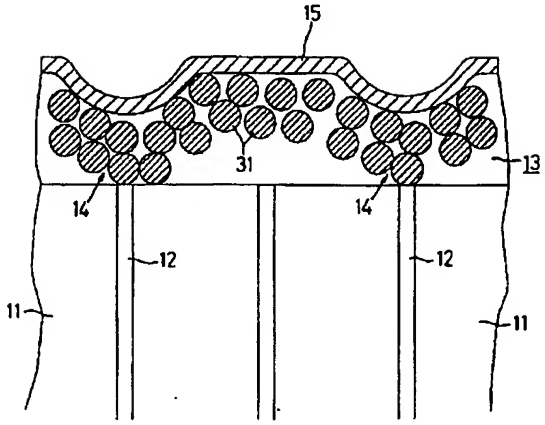
16
16a
16a
15
13
12
12
11
11

【図5】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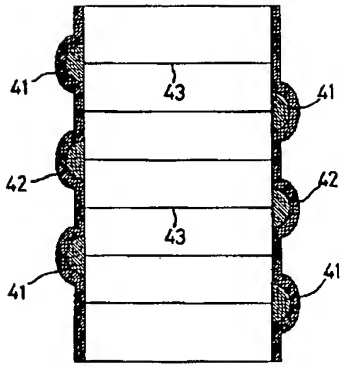
31
13
14
14
12
12
11
11

【図6】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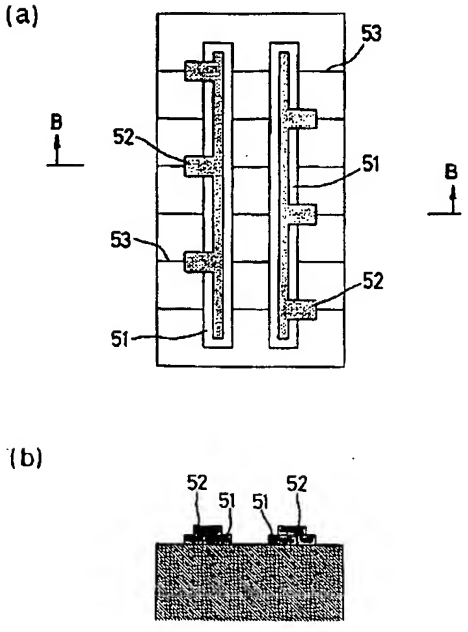
41

【図7】


(a)
53
B
52
51
B
53
52
51
(b)
52
51
51
52

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed description]
[0001]
[Field of the Invention] this invention carries out several multi-sheets laminating of the thin film of piezoelectric material, and relates to the laminating type piezoelectric device which obtains a lengthwise variation rate by impressing a voltage.
[0002]
[Prior art] although it is necessary to connect for setting an internal electrode much more when manufacturing a laminating type piezoelectric device, if the conventional multilayer-ceramic-capacitor formula is used -- the area of an internal electrode -- the cross section of an element -- a parvus sake -- the electric field -- the whole surface -- not generating -- a fraction not only checking a variation rate but uneven -- stress concentration -- generating -- just -- being alike -- there is a fatal fault of destroying moreover, the positioning at the time of a laminating -- difficult -- at most -- the case where about some dozens of laminating number of sheets is limitations, and it is the same applied voltage -- the variation rate of an element -- since an amount is proportional to laminating number of sheets -- a big variation rate -- it was difficult to manufacture the element which generates an amount
[0003] Although the technique of printing and carrying out the laminating of the electrode all over a piezo-electric sheet, i.e., the structure which makes equal the area of an internal electrode and the cross section of an element, is general in order to cancel this fault In order to connect for setting an internal electrode much more in the case of such structure, you have to carry out insulating processing using technique (drawing 6) which is indicated by the Japanese Patent Publication No. 17354 [63 to] official report, and the technique (drawing 7) which is indicated by the Provisional-Publication-No. 211974 [62 to] official report. That is, in the laminating type piezoelectric device shown in drawing 6 , after making the insulators (insulating layer) 41, such as glass, adhere to setting much more by screen-stencil or the electrophoresis method, it prints and fixes and has connected for applying the silver paste 42 which serves as an external electrode from on the, and setting the internal electrode 43 much more. Moreover, in the laminating type piezoelectric device shown in drawing 7 (a) and (b), the external electrode 52 formed on the internal electrode 53 and the insulating layer 51 forming the insulating layers 51, such as glass, similarly and setting much more is connected electrically.
[0004] However, although the process which forms an insulating layer on the side face of an element, and the process which forms the external electrode for connecting an internal electrode from on the are needed in the piezoelectric device of the structure shown in drawing 6 and drawing 7 Since an insulating layer will be formed previously in any case and an external electrode will be formed after that, those processes cannot be performed simultaneously, but moreover, there is a fault that there are many processes in order to have to form directly to an element mainframe, and the yield becomes low. Moreover, although the insulating layer 41 was formed for setting much more at the edge of the internal electrode 43 exposed to the side face in the case of the piezoelectric device of the structure shown in drawing 6 , when screen-stencil was used as the technique, since printing was very detailed, the fraction originally connected by the skip, blot, etc. might become defective continuity, and the fraction insulated might short-circuit. It was difficult to form uniformly the insulating layer 41 of only thickness which can bear the driver voltage of an element also in an electrophoresis method, and, similarly it had the problem

of the simplistic grade by dielectric breakdown.
[0005] On the other hand, at the piezoelectric device of the structure shown in drawing 7 , although the insulating layer 51 could be formed comparatively easily, the continuation of the external electrode 52 on an insulating layer 51 and the internal electrode 53 was difficult, since there was a level difference of an element side and an insulating layer in the case where it is screen-stencil, in the level difference fraction, printing of an electric conduction material paste was difficult, and defective continuity and the poor shunt had become the problem. Furthermore, while the manufacturing cost rose in order that the process which calcinates an insulating layer and external electrode paste at an elevated temperature might enter, even if it used which technique, when the thickness of a piezoelectric-material layer was set to 100 micrometers or less, there was a trouble where connection became very difficult.
[0006] Then, artificers tried the manufacture of an element using the anisotropy electric conduction layer of a particulate-material type which is shown in drawing 8 , in order to solve these problems. This anisotropy electric conduction layer is contained in the adhesion sheet 61 of the insulator with the thickness of about 100 micrometers in the status that it distributed so that the conductive grain 62 of 10 micrometers of particle-size numbers might not contact mutually, by pressurizing partially in the membranous thickness orientation, grain can contact and only the thickness orientation can give conductivity.
[0007] By this, the process which forms an insulating layer is omissible, since there is also no baking process in an elevated temperature, a process can be cut down sharply, and the manufacturing cost of an element can be pressed down. Moreover, in the formation process of an external electrode, since the paste of electric conduction material or an insulating material was not used, the faulty connection by a blot or the skip became that there is nothing.
[0008]
[Object of the Invention] However, since conductivity will be also perpendicularly acquired to the membranous thickness orientation by contact of grain if the distance between the conductive grain 62 is narrow when the anisotropy electric conduction layer of a particulate-material type which is shown in drawing 8 is used, the trouble where the connection of the piezoelectric film including the internal electrode set much more if the thickness of a part is set much more to 100 micrometers or less became difficult remained.
[0009] From the first, even if a piezoelectric film is the piezoelectric device of the thin film formed very thinly, it connects an external electrode and an internal electrode certainly that it is made in order that this invention may solve such a trouble, and the idea of formation of an insulating layer is eliminated, and a process can be simplified, and it aims at the ability to prevent defective continuity and a poor insulation.
[0010]
[The means for solving a technical problem] In order to attain this purpose the laminating type piezoelectric device of this invention The electric conduction layer which can give conductivity alternatively by compressing nothing and partially the structure where contained conductive grain and the inclusion concentration was made to change in the orientation of a thickness while it is formed succeeding the side face top, While it is formed succeeding the electric conduction layer top, it has the external electrode electrically connected with the internal electrode through the electric conduction layer. Moreover, let the electric conduction layer be one layer structure which consists of the resin adhesives containing conductive grain.
[0011]
[Operation] By compressing an electric conduction layer, the conductive grain of a fraction with the high inclusion concentration pressurized locally breaks through the fraction with low inclusion concentration, and the laminating type piezoelectric device of this invention which has the above-mentioned configuration comes to contact an internal electrode, and can give conductivity alternatively only to a desired fraction. And since, as for the fraction which is not pressurized, an insulation is secured by the low fraction of the inclusion concentration of grain, Since there is no limit that it must distribute so that only the distance with conductive fixed grain may separate and the whole fraction with high

inclusion concentration can be made to contain grain Even if a piezoelectric-material layer is the piezoelectric device of the thin film formed very thinly, it can prevent certainly that connect an external electrode and an internal electrode certainly and defective continuity and a poor insulation occur.
[0012] Moreover, since the electric conduction layer is therefore constituted in one layer structure which consists of resin adhesives, the process of printing at an elevated temperature is not required, and the manufacturing cost of an element can be held down.
[0013]
[Example] Hereafter, one example which materialized this invention is explained with reference to a drawing.
[0014] Drawing 1 is the cross section of the laminating type piezoelectric device by this invention, and has a current carrying part 14 for forming the electric conduction layer 13 so that all the piezoelectric-material layers 11 may be started in the orientation of a laminating of an element, and setting much more in the side face of a layered product in which the piezoelectric-material layer 11 and the internal electrode 12 lap by turns. Furthermore, on the electric conduction layer 13, as an external electrode, copper foil 15 is formed and it connects with the internal electrode 12 electrically through the current carrying part 14. The electric conduction layer 13 has one layer structure which conductive grain was contained [layer structure] and made the inclusion concentration change in the orientation of a thickness continuously.
[0015] Next, the manufacture technique of a laminating type piezoelectric device shown in drawing 1 is explained with reference to drawing 2 - drawing 5 .
[0016] First, after mixing the piezoelectric material which makes PZT a principal component to desired composition, add the plastic material and defoaming agent of the binder of 5 weight section, and a minute amount to the powder which carried out temporary baking at 850 degrees C, and it is made to distribute in an organic solvent, and is made the shape of a slurry. This slurry is fabricated in predetermined thickness by the doctor blade method, and it considers as a green sheet. On this green sheet, as an internal electrode 12, Pd paste is screen-stenciled, the predetermined number-of-sheets laminating of what was pierced in the predetermined dimension is carried out, and it unifies with a heat press. It sinters at about 1200 degrees C after a degreasing, and after considering as the sintering layered product 5 of a letter of a block which is shown in drawing 2 , it slices to the size for one piece of the element simple substance 6.
[0017] The resin adhesives which made the copper powder (conductive grain) 31 of 20-30 micrometers of mean particle diameters contain on copper foil 15 as an element mainframe as independently shown in drawing 3 , for example, thermosetting epoxy system adhesives, are uniformly applied in thickness of about 70 micrometers, it heats at temperature lower than a curing temperature, and changes into the malacia status, and a copper powder (conductive grain) 31 is made to sediment according to a specific gravity difference, and it changes into the status of semi-hardening further. although it is close to the electric conduction layer 13 15 of one layer structure which made the inclusion concentration of a copper powder (conductive grain) 31 change in the orientation of a thickness continuously, i.e., copper foil, so that the inclusion concentration of a copper powder (conductive grain) 31 is as high as ** and it separates from copper foil 15 by this -- inclusion concentration -- low -- becoming -- just -- being alike -- the electric conduction layer 13 of one layer structure which hardly contains a copper powder (conductive grain) 31, or does not contain it at all
[0018] Next, it carries out [tacking] by the length which is applied to the one side face of the element of the status that this electric conduction layer 13 was cut and sliced by width of face narrower than the width of face of an element at all the piezoelectric-material layers 11. As shown in drawing 4 , and by pitch P for two spacings of the internal electrode 12 The fixture for pressurization 16 in which the nose of cam had two or more Yamabe 16a of the letter of a salient formed in R (radii which are the radii of 0.05mm) which is about 0.05mm is prepared. If the whole is heated for 30 minutes at 150 degrees C, applying [position so that the position of the internal electrode 12 set much more with Yamabe 16a of each of that letter of a salient may gear, and] a load In the electric conduction layer 13 of the fraction pressurized while the electric conduction layer 13 and copper foil 15 pasted the element mainframe As

shown in drawing 5 , the copper powder 31 of a fraction with high inclusion concentration (conductive grain) The fraction with the low inclusion concentration of grain is broken through, and the internal electrode 12 is contacted, and the copper foil 15 which is an external electrode contacts, and it becomes the type where the internal electrode 12 and copper foil 15 were electrically connected for becoming a current carrying part 14 and setting much more.

[0019] Also in another side face, it shifts by one layer similarly and copper foil 15 is connected with the internal electrode 12 through the electric conduction layer 13. Then, the lead wire for electric power supplies is attached in a part of copper foil 15, sheathing and polarization are given, and it becomes a finished product.

[0020] Since the electric conduction layer 13 to this example at the time makes inclusion concentration of a copper powder (conductive grain) 31 one layer structure made to change in the orientation of a thickness continuously, for example, the resin adhesives which made the copper powder (conductive grain) 31 of 20-30 micrometers of mean particle diameters contain on copper foil 15 -- for example Thermosetting epoxy system adhesives are uniformly applied in thickness of about 50 micrometers, and it heats at temperature lower than a curing temperature, and changes into the status of semi-hardening, and further, on it, similarly, only adhesives are applied and heated uniformly and carry out semi-hardening. by this There are the following effects compared with the case where the electric conduction layer 13 which consists of the two-layer structure of the layer which consists of the epoxy system adhesives containing the copper powder (conductive grain) 31, and the layer which consists only of epoxy system adhesives is used.

[0021] In order to apply resin adhesives to the 1st, it is not necessary to carry out screen-stencil twice, and it becomes a man day reduction. Moreover, the heating process of 2 times is not needed. Although it is easy to produce thickness nonuniformity on an electric conduction layer when carrying out screen-stencil to the 2nd twice in the case of two-layer structure, in the case of one layer structure, adjustment of a thickness is easier than two-layer structure.

[0022] In addition, this invention is not limited to the example mentioned above, and unless it deviates from the main point, it can add various change. For example, you may use metal powders, such as nickel and silver, instead of using a copper powder as conductive grain 31. Moreover, if one side of copper foil 15 is extended as it is, it will become instead of lead wire. Furthermore, if an element is pinched in a position where the two aforementioned fixtures for pressurization 16 are prepared, and the each **** and trough gear, the 2nd page can be pressurized simultaneously.

[0023]

[Effect of the invention] having explained above **** -- expiring -- kana -- the laminating type piezoelectric device of this invention like It is not necessary to form an insulating layer in each element, since there is also no baking process in an elevated temperature, can cut down a process sharply, and can press down the manufacturing cost of an element, and it sets at the formation process of an external electrode. Since the paste of electric conduction material or an insulating material is not used, even if it is the piezoelectric device of the thin film in which the piezoelectric-material layer was formed very thinly that the faulty connection by a blot or the skip can be made for there to be nothing from the first, an external electrode and an internal electrode are connected certainly and there is no possibility of starting defective continuity and a poor insulation.

[0024] Moreover, since the electric conduction layer is made into one layer structure which consists of the resin adhesives containing conductive grain, it can manufacture easily by the technique of the grade which makes conductive grain sediment according to a specific gravity difference, and the process of printing at an elevated temperature is not required, and the manufacturing cost of an element can be pressed down.

[Translation done.]

NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[An easy explanation of a drawing]
[Drawing 1] Drawing 1 is the cross section of the laminating type piezoelectric device which shows one example of this invention.
[Drawing 2] Drawing 2 is explanatory drawing cut down from the sintering layered product of the letter of a block to the size for one element.
[Drawing 3] Drawing 3 is the cross section showing copper foil and the electric conduction layer of one layer structure.
[Drawing 4] Drawing 4 is explanatory drawing of the process which pressurizes an electric conduction layer.
[Drawing 5] Drawing 5 is explanatory drawing showing the status that the current carrying part was formed of pressurization.
[Drawing 6] Drawing 6 is the cross section of the conventional laminating type piezoelectric device.
[Drawing 7] Drawing 7 shows other conventional laminating type piezoelectric devices, (a) is a side elevation and (b) is the B-B line cross section of (a).
[Drawing 8] Drawing 8 is the cross section of the anisotropy electric conduction layer proposed previously.
[An explanation of a sign]
11 Piezoelectric-Material Layer
12 Internal Electrode
13 Electric Conduction Layer
14 Current Carrying Part
15 Copper Foil (External Electrode)
16 Fixture for Pressurization
31 Copper Powder (Conductive Grain)

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

NOTICES *

CLAIMS

[Claim]
[Claim 1] While piezoelectric material and an internal electrode are the laminating type piezoelectric devices by which the laminating is carried out by turns and formed succeeding the side face top of the laminating type piezoelectric device While it is formed succeeding its electric conduction layer [which can give conductivity alternatively by compressing nothing and partially the structure where contained conductive grain and the inclusion concentration was made to change in the orientation of a thickness], and electric conduction layer top The laminating type piezoelectric device characterized by having the external electrode electrically connected with the aforementioned internal electrode through the electric conduction layer.
[Claim 2] The aforementioned electric conduction layer is the laminating type piezoelectric device of the claim 1 publication characterized by being one layer structure which consists of the resin adhesives containing conductive grain.
